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(71) Applicant(s)  
B & H Liquid Crystal Devices Limited  
(Incorporated in the United Kingdom)  
The Pavilions, East Road, Wimbledon, LONDON,  
SW19 1UW, United Kingdom

(72) Inventor(s)  
William James Stephen Barker

(74) Agent and/or Address for Service  
J Y & G W Johnson  
Kingsbourne House, 229-231 High Holborn, LONDON,  
WC1V 7DP, United Kingdom

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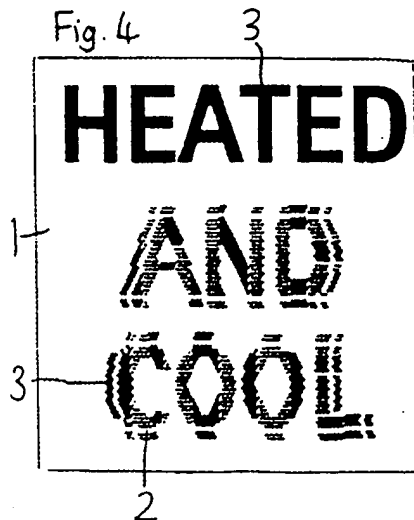
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(56) Documents Cited  
GB 2326866 A US 5925593 A  
US 5786578 A

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(54) Abstract Title  
Temperature indicator

(57) A temperature indicator bears information printed with a first thermochromic ink (3) which is non-visible at ambient temperature and a second thermochromic ink (2) which becomes visible at a temperature different from the temperature at which the first thermochromic ink becomes visible. The combination of the first and second inks, when both are visible, shows information which was not revealed prior to a change in temperature.



GB 2 373 338 A

Fig. 1

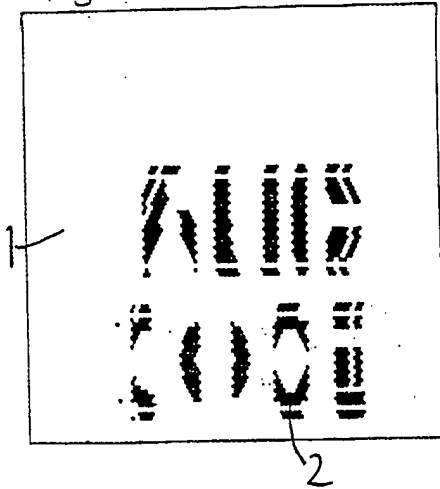


Fig. 2

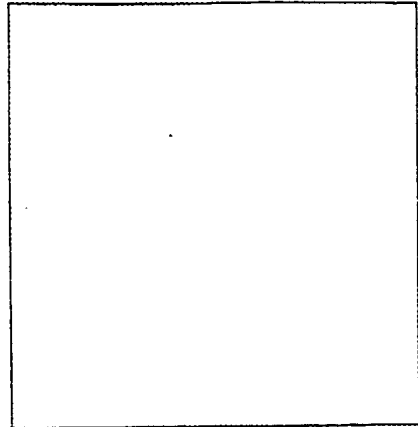
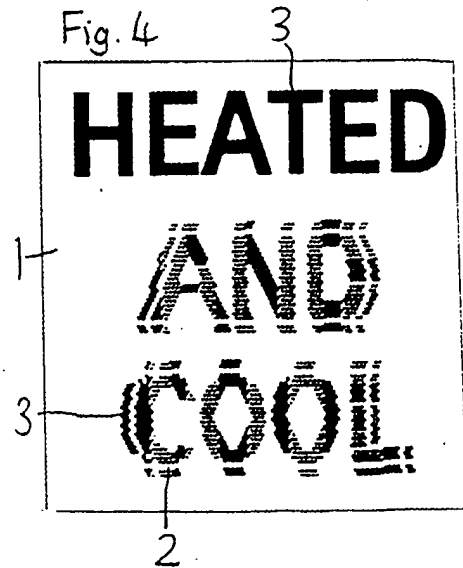


Fig. 3



Fig. 4



### TEMPERATURE INDICATOR

This invention relates to a temperature indicator for indicating that two or more temperature points have been reached or exceeded. The temperature points to be reached  
5 may or may not have a required sequence, one before the other. The indication of the achievement of the temperatures is shown by way of colour change that can be on a printed label, a card, on packaging, directly on a product or in other embodiments.

Colour changing temperature sensitive labels and devices are known whereby a  
10 temperature reached will cause a permanent or reversible colour change in a label or thermometer strip. Microencapsulated liquid crystal compositions and organic and inorganic compounds can achieve this. However, the requirement for a specific sequence of temperature events to be recorded makes known irreversible permanent temperature indicators and reversible indicators unsuitable.

15 The present invention provides a temperature indicator, such as a label, bearing information printed with a first thermochromic ink which is non-visible at ambient temperature and a second thermochromic ink becoming visible at a temperature different from the temperature at which said first thermochromic ink becomes visible,  
20 the combination of said first and second inks, when both are visible, showing information which was not revealed prior to a change in temperature. The revealing of the first temperature achieved continues to be indicated when the second temperature reveal is also triggered, thereby showing that both temperatures have now been reached.

25 Preferably, the first thermochromic ink is irreversible, i.e. once visible its appearance is not affected by subsequent changes in temperature. The second thermochromic ink is preferably reversible, returning to its original appearance once a triggering temperature is again reached.

30 In a particular embodiment of the invention, the first and second inks provide two components of a message, the message only being readable when both inks are visible.

One particular use of such a device is to indicate where a food or liquid has been heated to a required temperature, and has then cooled sufficiently to be safely consumed. (Some examples would be pies, custard, soups, baby foods, any pre-cooked ready to re-heat meals, coffee, chocolate drink etc). Other uses can be found in the monitoring of industrial and commercial processes and in heat sterilisation for instance. This device could be used in test verification or to provide production data for ISO 9000 processes, or to support environmental management systems for ISO 14000 purposes.

Therefore, a label, wrapper or container for instance could show when a product on which it was attached had reached an initial temperature required of 100 °C for example, by an area of a colour changing composition, which changed colour. On then cooling to 45 °C for instance, a further part of the label changed colour to show that this second temperature had now been reached, whilst still indicating that the first had been achieved.

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows an indicator according to an embodiment of the invention, prior to use,

Figure 2 shows the indicator of Figure 1, at an elevated temperature,

Figure 3 shows the indicator at or above a first trigger temperature, and

Figure 4 shows the indicator after returning to a temperature at or below a second trigger temperature.

Figure 1 shows an indicator in the form of a label comprising a substrate 1 that is typically a paper carrier or base optionally provided with a permanent display, e.g. a conventional printing ink (not shown). In addition, a first thermochromic ink, which initially and in its normal operating condition is colourless and invisible, is used to print onto the substrate one part of the information. A second thermochromic ink 2 is used to print onto the substrate a second part of information.

Figure 2 shows how on heating the indicator to above a second trigger temperature (which may be between 30 °C and 50° C, e.g. 45 °C), the second thermochromic ink becomes colourless and invisible.

- 5    Figure 3 shows the effect of raising the temperature of the indicator to or above a first preformulated trigger temperature (which may be between 70 °C and 300 °C, e.g. 100 °C). The state of the first thermochromic ink 3 is irreversibly changed so that the ink becomes visible by acquiring colour.
- 10   Figure 4 shows that, following this event, the effect of lowering the temperature of the indicator is to change the state of the second thermochromic ink 2 so that this ink again becomes visible by acquiring colour when it reaches its preformulated trigger temperature (the same, or approximately the same, temperature at which it became invisible).
- 15   The combination of the two thermochromic inks thereby indicates that not only has the first temperature (of 100 °C) been achieved, but also now the second and lower temperature of 45 °C has been reached. In the case of a food or drink item a user thereby knows that the item has been heated and cooked, and is now cool enough to consume.
- 20   In this example, the first thermochromic ink 3 used is an irreversible ink, which becomes coloured (e.g. black) and indicates in part of the label that the required trigger temperature has been reached, whilst revealing an amount of information in another part, which is not complete.
- 25   The second thermochromic ink 2 used in this example is reversible ink of electron donor-acceptor type, known to those skilled in these fields, such as available from Matsui, which in its temperature state below its trigger point becomes coloured and above this point becomes clear.
- 30   In this example the information printed using the second ink 2 is incomplete such that when the item is at a temperature below the trigger point of the second ink (e.g. 45°C) the information revealed is not complete as to giving any meaning. Only on the triggering of

the first thermochromic ink 3 (on reaching 100°C) and the revealing of the second part of information is it possible to reveal a meaning to the combination of the information.

5 Therefore as the item is heated, the second ink 2 changes from being visible to becoming invisible until a point at which the first ink 3 reacts and becomes revealed. As the item is cooled the first ink 2 remains visible, and the second ink 3 then also becomes visible at the lower trigger point completing the information to show that the item has cooled sufficiently.

10 The substrate may be plastic, paper or any other printable material, the method of printing only limited by its ability to lay the thermochromic materials in predetermined areas on the substrate.

15 Usually such printing of thermochromic materials is performed by screen-printing, flexographic printing, lithographic printing etc by inclusion of the thermochromic materials into a printing ink or coating.

Other methods of printing such as photocopying or thermographic printing are also possible. The images so formed may be made up of areas of lines, solids or dots.

20

A "thermochromic ink" as used in this specification means an ink which changes colour or opacity reversibly or irreversibly with increasing or decreasing temperature, e.g. transparent to opaque, transparent to a colour or a colour to a different colour or hue of a colour.

25

It should be understood that more than two temperatures could be recorded.

CLAIMS

1. A temperature indicator, bearing information printed with a first thermochromic ink which is non-visible at ambient temperature and a second thermochromic ink  
5 becoming visible at a temperature different from the temperature at which said first thermochromic ink becomes visible, the combination of said first and second inks, when both are visible, showing information which was not revealed prior to a change in temperature.
- 10 2. A temperature indicator according to claim 1, wherein the first thermochromic ink is irreversible, i.e. once visible its appearance is not affected by subsequent changes in temperature.
- 15 3. A temperature indicator according to claim 1 or 2, wherein the second thermochromic ink is reversible, returning to its original appearance once a triggering temperature is again reached.
- 20 4. A temperature indicator according to claim 1, 2 or 3, wherein the first and second inks provide two components of a message, the message only being readable when both inks are visible.
5. A temperature indicator according to any preceding claim, comprising a label, wrapper or container for a comestible product.
- 25 6. A temperature indicator according to any preceding claim, wherein said first thermochromic ink becomes visible between 70 °C and 300 °C.
7. A temperature indicator according to any preceding claim, wherein said second thermochromic ink becomes visible between 30 °C and 60 °C.
- 30 8. A temperature indicator, substantially as described herein or with respect to the accompanying drawings.



Application No: GB 0202382.8  
Claims searched: 1-8

Examiner: Carol Davies  
Date of search: 9 July 2002

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK CI (Ed.T): G2C (CHR, CHX)  
Int CI (Ed.7): B41M 3/14, 5/28; G09F 3/02  
Other: ONLINE: EPODOC, JAPIO, WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2326866 A (HOLMES)	
A	US 5925593 (NATIONAL INK INC)	
A	US 5786578 (CHRISTY)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.



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